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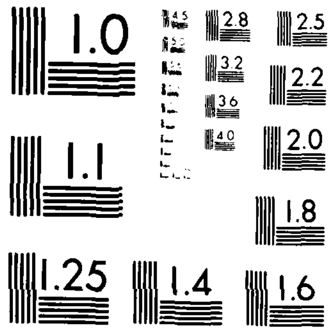

MICROCOPY RESOLUTION TEST CHART

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VOLUME III

PRODUCT DEFINITION DATA INTERFACE

Final Technical Report

Volume Number III

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Robert A Carringer | 30 APR 1984

Robert A. Carringer, Lt. USAF
ICAM Project Manager

Date

FOR THE COMMANDER:

N G Tupper | 30 APR 84

Nathan G. Tupper
Chief
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Date

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The overall objective of the PDDI project is to develop and demonstrate a computer-driven interface between engineering and manufacturing. This document deals only with Task I and describes the development of a test procedure for evaluating the effectiveness of CAD to CAD part model translations between different vendor systems. In addition to the test procedures, results from field testing of IGES translators for 12 different CAD systems are included.

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FOREWORD

This Final Technical Report covers the work performed under Air Force Contract F33615-82-C-5036, "Product Definition Data Interface, 1 October 1983, through 30 November 1983. The contract is sponsored by the Computer Integrated Manufacturing Branch, Materials Laboratory, Air Force Wright Aeronautical Laboratories, Air Force Systems Command, Wright-Patterson Air Force Base, Ohio, 45433. This program is being administered under the technical direction of Lt. Robert A. Carringer, Project Manager.

McDonnell Aircraft Company (MCAIR) is the prime contractor with Booz, Allen & Hamilton, United Technology Research Center (UTCR), and an Industry Review Board as subcontractors. This program is managed by Mr. Peter J. Downey and Mr. Edwin B. Birchfield. The Booz, Allen & Hamilton Officer-In-Charge is Mr. Charles S. Skinner and the Program Managers are Dr. Ralph Dratch (Task I) and Mr. John McCracken (Task II). Mr. Mark Dunn is the United Technology Research Center Project Manager. Mr. Jim Lardner of John Deere & Company is chairman of the Industry Review Board.

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1.0 INTRODUCTION

Volume II of this report presents a detailed description of the procedure that was used to perform an evaluation of IGES Version 1.0. This procedure was developed to achieve the goals and objectives of Task I as discussed in Section 1.0 of Volume II. However, another objective of the program, as identified by the project sponsors - the U.S. Air Force ICAM program office, is to contribute to the CAD/CAM community of equipment vendors and systems users a general method of assessing the effectiveness of IGES processors. Such a method could be put to a variety of uses in the course of:

- Processor development efforts, as a "debugging" tool.
- Testing implementations of newly purchased processor software.
- Resolving conflicts between product definition communicators, by serving as a "standard" test.
- Certifying data exchange processors as appropriate for a particular application.

In this regard, Volume III presents a version of the Task I test methodology which has been generalized so as to be useful in such situations. Though based on the approach and procedures presented in Volume II, the methodology described in this volume is not specific to the Task I test scenario.

Volume III is formatted as a stand-alone document to be read by those whose interest is primarily concerned with performing a test of an IGES processor or a similar data exchange vehicle. Background, philosophy and descriptions of Task I and IGES have been left out to simplify the task of reading the material. Where appropriate, the reader is referred to Volume II for specific examples of an application of the general methodology.

2.0 TEST RESOURCE REQUIREMENTS

In order to perform the detailed test procedures described in Chapter 4 of this volume, a number of different resources are required which will usually dictate the need for a team of people to perform the testing. Table 1 indicates the normal resources required to perform a test.

Table 2-1
List of Resources Required to Perform Test

Hardware	Software	Human Resources
• CAD/CAM System	• IGES Translators (Pre & Post)	• CAD Operator
• High-Resolution Screen	• Sample Test Files	• Systems Analyst*
• Plotter		• Systems Hardware Personnel*
		• CAD System Programmer*

* These resources are required only on a standby basis.

The systems analyst and systems hardware personnel are required on a standby basis only to address any software or hardware issues that arise during testing. A systems analyst needs an understanding of data mapping requirements between the CADD system and the IGES software. A CAD system programmer with an understanding of the capabilities and limitations of the CAD system is also needed on a standby basis to resolve questions of mathematical accuracies of geometric definitions and surface intersections. In addition to the resources listed above, a detailed understanding of IGES translator entities and their attributes is required as well as experience in reading IGES file listings.

3.0 TRANSLATOR EVALUATION CRITERIA

Test results can be evaluated on the basis of three fundamental issues - accuracy, legibility, and functionality of transferred data. Legibility refers to the ability of a person to unambiguously interpret part models after they have been either pre- or post-processed. Functionality refers to the ability of the receiving system to handle the CAD data as if they were originally created on the participant's CAD system. Accuracy is a measure of the exactness of the processed data with respect to the original data.

In defining accuracy, legibility, and functionality in this manner, it must be recognized that the use of IGES is application dependent. Each application will place varying requirements on the importance of these issues. CAD-to-CAM transfer will be concerned with accuracy and functionality of the geometry to be machined. In CAD-to-CAD transfer, when working only with blueprint models, one would be more concerned with the accuracy of the part model and the associated digital notes.

Each user needs to establish a priority of these criteria based on the requirements of the CAD/CAM environment. The specific criteria which are used to perform an evaluation are:

- Completeness - the degree to which all part data appear in a display of the processed information.
- Legibility - the degree to which the display can be unambiguously interpreted.
- Geometric Accuracy - the degree to which geometric parameters, such as dimensions, shapes, and intersections, are properly represented.
- Functionality - the degree to which processed part data have been treated as if they were generated on the system being tested.
- Attributes - the degree to which entity attributes are correctly handled by the test system.

Evaluation sheets are created for documenting test results. These forms contain a section detailing every entity type that is contained in the test files used during translator evaluation. By using this method, test results can be evaluated on an entity-by-entity basis. A scale that is used during evaluation involves breaking down entity performance into one of five possible categories.

These five categories are:

- High - translation was correct with full completeness, legibility and functionality.
- Medium - Minor errors were encountered or there was a minor loss in either completeness, legibility or functionality.
- Low - Although the entity was translated, there was a major translation error or the functionality and/or completeness was lost.
- Null - No translation was made because of catastrophic failure during processing or the entity was not implemented.
- Not Tested - The entity was not tested due to circumstances outside the scope of the test.

Figure 1-1 shows an example of a chart that could be used to document translator performance.

Processor	IGES Entity			
Criteria (Weight)	100 Circular Arc	110 Composite Curve	110 Line	...
Completeness ( ) Legibility ( ) Geometric Accuracy ( ) Functionality ( ) Attributes ( )				
Average Rating				

Figure 3-1
Sample Translator Evaluation Sheet

4.0 TEST METHODOLOGY

IGES software is composed of two translators, a pre-processor and a post-processor. The pre-processor is used to translate a part representation in a specific CAD system to a neutral IGES file format while the post-processor is used to translate an IGES file into the format used by a particular vendor system. Because of their different functions, and the fact that they are different software packages, the pre- and post-processors are evaluated separately. In fact, a user may be only concerned with either the transmission or the reception of data. However, to properly evaluate on IGES data link, both the pre- and post-processors should be evaluated as a pair even though the software may reside at a different user's site or in different hardware.

4.1 OVERVIEW OF PRE-PROCESSOR TESTING

Pre-Processor evaluation begins with the creation of models of the test-case parts. The part models may consist of both special test cases such as the IGES test library, and examples of production parts. After the part models are entered into the CAD system, a hardcopy of the models is obtained as a record of the representations existing in the originating CAD system. The files are then pre-processed and stored for subsequent pre-processor evaluation which may include methods such as "full-circle" testing, jury or receiving system evaluation, or hand checking. Figure 1-2 shows the steps associated with pre-processor testing.

In order to properly evaluate pre-processor performance, a combination of methods is recommended. The first method involves a "full-circle" test of the IGES translator. The test is designed to examine how well a CAD system can handle pre-processed files that are "self" generated. In order to perform this step, a post-processor is required to post-process the IGES files. The IGES files are post-processed on the test system and a hardcopy of both entities translated and diagnostic messages is made for use during analysis. The resultant part models are brought up at the CAD station and displayed. Standard reference lengths are selected to ensure that the correct scale was maintained during translation. A plot of the part is made to record the result of test file translations. Plots are used for comparison with the original plots that depict the correct representation.

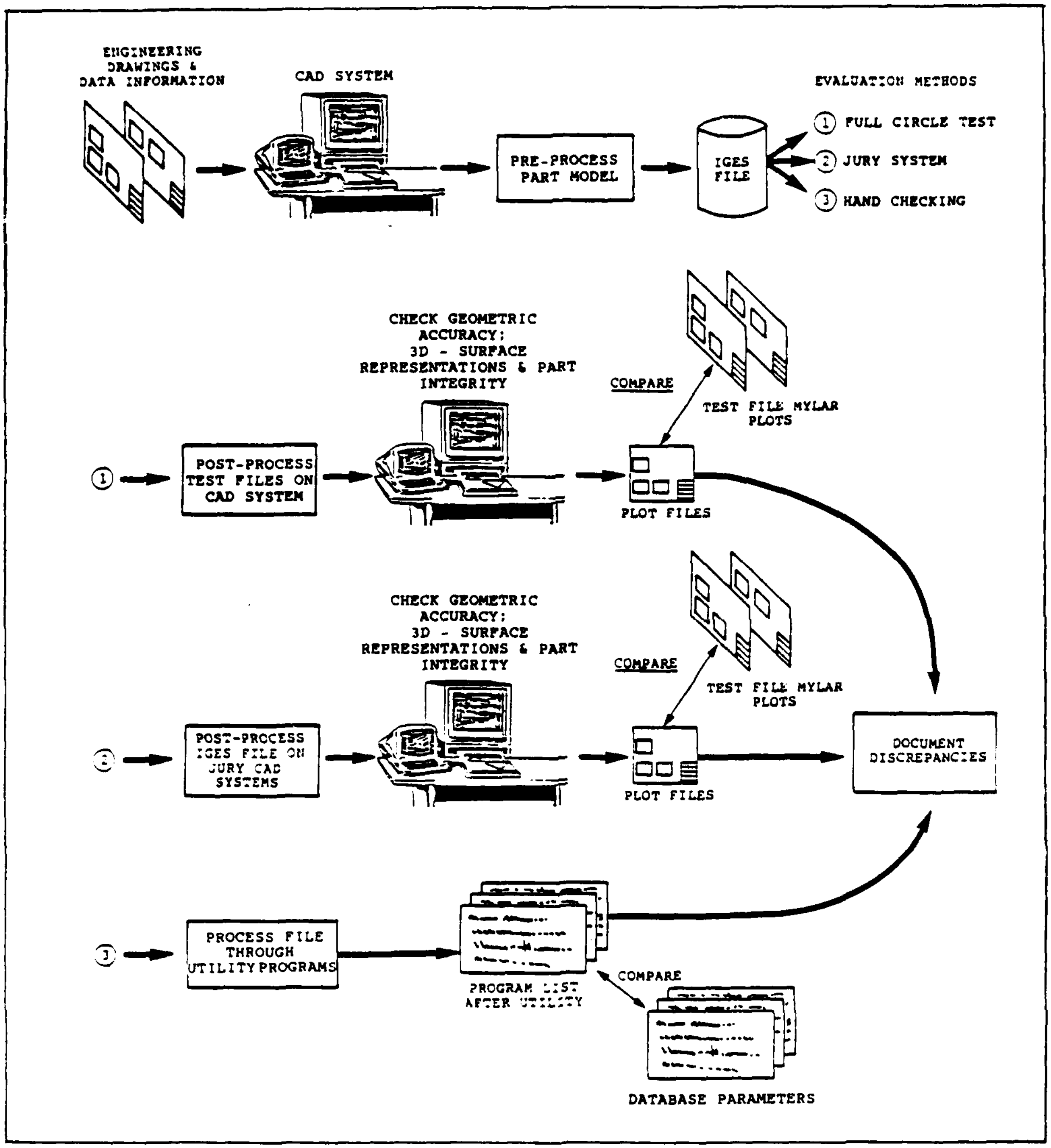

Figure 4-1 Pre-Processor Test Steps

The part is then rotated, scaled, and viewed normal to different planes to check for any annotation or geometry that may not be in the correct location, or that may not be seen in a standard view. The part is then checked for correct end-point conditions of entities by either using a chain-select feature or an NC-model validation routine. This portion of the test checks to see if a model is connected from one entity to another.

The next step of the test involves a functional check of the translated model. Functionality is defined as the ability of the CAD system to handle parts as if they were created on the system being tested. Each piece of annotation is selected to determine the entity type after translation. Text is then edited and moved using functions that are normally supported by the CAD system being used. The last functionality test involves the selection of entities that are coded as group associativities in the IGES files. A member from the group is selected, and if it has been correctly post-processed, the remaining group members should be automatically selected.

Surfaces, if present, are checked for accuracy by determining the intersection of lines with the surface. Predetermined lines that intersect the surfaces are entered by the CAD operator. The operator then finds the intersection of the lines with the surface using a CAD system command. These intersection points are compared with previously calculated points of the theoretical intersection.

The last step involves a comparison of the system-generated plots with the original plots. Geometric inaccuracies are identified, as well as problems associated with annotation, such as misplaced leaders, text size, or text placement.

The second pre-processor evaluation method is based on the use of a "jury system". The jury is comprised of other CAD systems that are known to exhibit a high level of implementation. All pre-processed files obtained from the originating CAD system are post-processed on the jury systems and evaluated for completeness and correctness of translation using the same procedures discussed for the "full-circle" test.

The third method of evaluating pre-processed IGES files may seem to be the most straightforward, but in reality is not. This method involves manually checking lines of code in the pre-processor output against a "correct" version. There are two major difficulties in using this method. First, hand checking the files on a line-by-line basis is an extremely tedious undertaking since each processor may arrange the IGES entities in a different order, define the entities with a different, but equivalent coordinators, and/or use alternative IGES representations. For this reason binary comparisons between IGES files cannot be made. Additional files are generally lengthy even for relatively simple parts. Second, there are few examples available of complete IGES files which are recognized as being correct with respect to the Standard to use as comparison.

Sources of "correct" files include those developed in conjunction with Task I and the NBS IGES test library. These files are available through the National Bureau of Standards. However, the test cases depicted in these files may not be suitable for a particular evaluation. In this case, the test team may want to consider several alternatives:

- Develop a "standard" IGES file for the test parts.
- Compare the test pre-processed IGES file with the part representations in the CAD-system database. For many CAD systems the internal representation of the part is similar enough to the IGES representation to be used as a basis of comparison.
- If this is not the case, develop a utility to convert the CAD-system representation and the IGES test file into a third format, such as an NC CL file, and compare them on this basis.
- Use the IGES test library of sample entities as a means of comparison.

Unfortunately, there is no simple procedure that can be used to check IGES-formatted files directly for correctness.

4.2 OVERVIEW OF POST-PROCESSOR TESTING

Post-processor testing begins with a communication compatibility check. A sample file is passed to the receiving computer system to verify that an IGES file can be read. Currently, the most common method of passing files is by using magnetic tape which requires a check of the density, block length, and record length.

The next step, shown in Figure 1-3, involves the post-processing of IGES test files. Test files may come from the National Bureau of Standards' test library which contains over 50 different cases, or from the transmitting system of an IGES link. Again, use may be made of he IGES files developed for Task I testing if the test cases are judged to be suitable for this purpose. A hardcopy of entities translated and diagnostic messages is made for use during the analysis phase. The part models are then brought up on the CAD system and manipulated and verified using the same procedures as explained under "full-circle" evaluation for pre-processor testing.

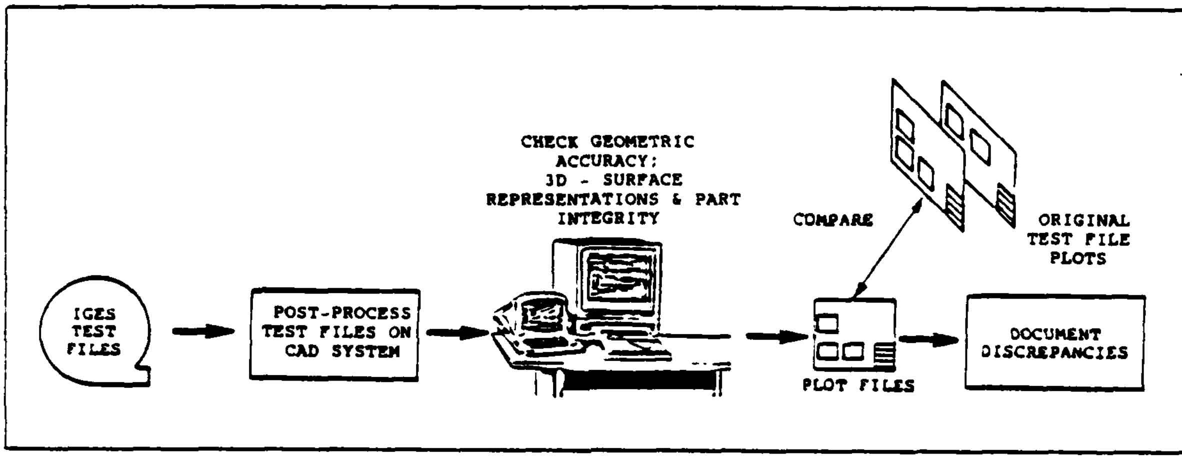

Figure 4-2
Post-Processor Test Steps

4.3 DETAILED TEST PROCEDURES

This section describes the sequence of steps that are carried out to accomplish testing. As in the previous section, a distinction is made between pre- and post-processsor test segments.

4.3.1 Pre-Processor Testing

1. Input Part Representations: Part models are created for use during pre-processing. These models may consist of either special test cases or production part models. Special test cases would usually consist of files that contain many variations of one or more entities. Geometric entity test cases should contain as many extremes as possible for a given mathematical definition. For example, when creating a spline test case, the number of segments, degree of the equation, slope conditions, and curve shape are all variables that may warrant cases in a part model. In the case of annotation, various display forms for a dimension type should be created.

An example might be inside versus outside leaders, or multiple- versus single-segment leaders. If production part models are used, a model that most closely resembles day-to-day production may be selected for testing purposes.

2. Generate Verification Geometry: The CAD operator should add simple geometry to the part models created in Step 1 for later use in verifying of geometric accuracy. The geometry added should consist of simple points or lines that intersect the geometric entity. Points should be placed directly on wireframe geometric entities. The number of points added to a model will vary according to the complexity of the part model and the variety of geometric forms. Special geometric test cases would probably warrant a greater number of points. For surfaces, either a random array of points should be placed on top of the mesh or lines should be placed in a manner so as to intersect the surface mesh.

   If the latter approach is used, the intersection points of the lines and the surface should be recorded. When this step is performed, it is essential to have an understanding of the CAD system surface and intersecton routines before drawing conclusions about surface accuracy.

3. Obtain Hardcopy of Part Representations: These plots should be of sufficient size and accuracy to allow for accurate verification of geometric and annotative information. Three-dimensional part models are plotted in three views using orthographic projections of the representations, in addition to an isometric view. These plots capture what the part models originally "looked like" on the CAD system before undergoing translation.

4. Document Part Model: The entities contained in the part model created in Step 1 should be individually defined by entity endpoints and documented on a plot of the model. While it may not be necessary to document all entities in the model, at least all unique entities should be covered for both geometry and annotation. Part models can be documented by creating a label that describes the entity type with an arrow that points to the actual entity. If the CAD translators are known to support text the information can be added directly to the CAD model. Otherwise, this step should be performed by manually drawing the information on the plot.

5. Pre-Process Part Representations: The part representations developed on the CAD system are pre-processed using the IGES pre-processor software. Any indication of the quality of the translation, as indicated by diagnostic messages, should be recorded.

This includes items such as number and types of entities translated, entities that do not translate, or any other feedback available from the IGES pre-processor.

6. Record IGES Files on Magnetic Tape; If magnetic tape is to be used for transmission of the files, record them in accordance with IGES recommended practice. The recommended tape format is: 9-track; 1600 BPI unlabeled; 800 bytes/block; 80 bytes/record.

At this point, three methods can be used for pre-processor evaluation. It is recommended that a combination of all three methods be used to ensure a number of different cross-checks. These include full-circle, jury evaluation and hand checking. The methods used for evaluation of the pre-processor will vary depending on availability of:

- A post-processor on the same CAD system.
- Other CAD systems with superior IGES processors to serve as a "jury".
- Personnel with the required skill sets to handle both mathematics and CAD system interfaces.

The following steps describe these three methods. When a sequence of operations is repeated in several different steps in the procedure, it will only be fully described once and referenced in other steps to avoid unnecessary repetition of text.

4.3.1.1 Full-Circle Test

7. Post-Process IGES Files on CAD System: IGES part models which are originally created by the pre-processor are post-processed on the system in a similar fashion as described in Step 33 of post-processor testing, Section 4.3.2.

8. Bring Model Up on CAD Screen: As in Step 34 of post-processor testing, the model is brought up on the CAD system for evaluation and manipulation.

9. Check View and Orientation of Part Representations: The part representaton is observed on the CAD system, as in Step 35 of the post-processor procedure.

10. Check Correct Translation of Scale and Units of Measurement: Reference features with a known size are checked using the CAD system to ascertain that the correct scale and unit of measurement is maintained as in Step 36 of the post-processor procedure.

11. Obtain Hardcopy of IGES Translations: As in Step 37 of the post-processor procedure, plots are made of the part models.

12. Functionality Check: A check is performed to verify the functionality of the part model as explained in Step 38 of the post-processor procedure.

13. Evaluate Annotation: Each piece of annotation is evaluated as described under post-processor procedure Step 39.

14. Check Geometric Entity Mappings: The CAD model is analyzed to determine how geometric entities are mapped between the sending and receiving systems as in Step 40 of post-processor testing.

15. Check Wireframe Geometric Accuracy: The CAD operator finds the distance from geometric verification points to the geometric entity in a similar fashion to Step 41 of post-processor testing.

16. Check 3D Surfaces: Surfaces are checked by finding distances from geometric verification points and intersection points to the surface mesh as described in Step 42 of post-processor testing.

17. Compare Hardcopy of IGES Translations with Original Part Plots: Hardcopies obtained from the plotting of the IGES translations are compared with the original plots of the part models in the same manner as in Step 43 of the post-processor procedure.

4.3.1.2 Jury Evaluation

18. Establish Communication Link: A sample IGES file should be exchanged between possible jury members as explained in Step 32.

19. Post-Process IGES Files on CAD System: IGES part models which are created by the pre-processor are post-processed on the jury system as in Step 33 of post-processor testing.

20. Bring Model Up on CAD Screen: As in Step 34 of post-processor testing, the model is brought up on the CAD system for evaluation and manipulation.

21. Check View and Orientation of Part Representations: The part representaton is observed on the CAD system, as in Step 35 of the post-processor procedure.

22. Check Correct Translation of Scale and Units of Measurement: Reference features with a known size are checked using the CAD system to ascertain that the correct scale and unit of measurement are maintained as in Step 36 of the post-processor procedure.

23. Obtain Hardcopy of IGES Translations: As in Step 37 of the post-processor procedure, plots are made of the part models.

24. Functionality Check: A check is performed to verify the functionality of the part model as explained in Step 38 of the post-processor procedure.

25. Evaluate Annotation: Each piece of annotation is evaluated as described under post-processor procedure Step 39.

26. Check Geometric Entity Mappings: The CAD model is analyzed to determine how geometric entities are mapped between the sending and receiving systems as in Step 40 of post-processor testing.

27. Check Wireframe Geometric Accuracy: The CAD operator finds the distance from geometric verification points to the geometric entity in a similar fashion to Step 41 of post-processor testing.

28. Check 3D Surfaces: Surfaces are checked by finding distances from geometric verification points and intersection points to the surface mesh as described in Step 42 of post-processor testing.

29. Compare Hardcopy of IGES Translations with Original Part Plots: Hardcopies obtained from the plotting of the IGES translations are compared with the original plots of the part models in the same manner as in Step 43 of the post-processor procedure.

4.3.1.3 Hand Checking

30. Process Part Files Through Utility Programs: The pre-processed files can be run through a utility program, similar to the program developed by McDonnell Douglas, that reduces the complexity of an IGES file by:

- Eliminating matrix transformations by moving an entity from local to global coordinates.
- Sorting files by entity type.
- Sorting within an entity type by selected parameter data.
- Identifying syntax errors in the files.

This utility will be in the public domain from McDonnell Douglas, but is designed to run only on IBM equipment as it contains IBM assembler language. Maintenance and updating of this program is not supported by McDonnell Douglas. Listings of the sorted pre-processed IGES files are used for Step 31. An example of such a listing is presented in Appendix D of Volume II of this report.

31. Perform Hand Checking: Checks of the pre-processed file entity representations and their associated parameter values are made with the entity representations and parameter values of a "standard" file as previously discussed in Section 4.1. Comparisons should include selected features which either full-circle or jury evaluations do not resolve. In addition, spot checks should be made for each entity type to determine if invalid information is present. Implementation problems that are found in the three verification methods are correlated. Results of these three tests are combined to establish the implemenation level and problems associated with pre-processor software. A discussion on the evaluation criteria to grade IGES translators is contained in Section 3.0 of this volume.

4.3.2 Post-Processor Testing

This section describes the steps used to evaluate a post-processor. Files used to perform this section may come from another IGES pre-processor, National Bureau of Standards Test Library, or hand-generated test files.

32. Establish Communication Link: The purpose of this step is to verify the ability of the sending and receiving computer system to exchange IGES files. A sample IGES file should be exchanged between the two systems. If telecommunications methods are being used, then a sample file should be transmitted electronically to the receiving system to check for compatible communication parameters and protocols. If magnetic tape is being used, then a sample IGES tape should be used. The format recommended for transporting IGES files on magnetic tape is discussed in Step 6.

33. Post-Process IGES Files: IGES files are translated on the receiving CAD system using IGES post-processor software. Information regarding the performance of the translation is recorded on hardcopy. Items of interest include the number of entites translated for each IGES entity, number of entites skipped, or any other status feedback that is available concerning the IGES translator. The amount of feedback given to the user varies for each vendor system. Feedback of this nature is extremely useful especially when dealing with CAD part models of significant size as untranslated entities may otherwise go unnoticed.

34. Bring Model Up on CAD Screen: Translated part models should be brought up on the CAD system for evaluation and manipulation.

35. Check View and Orientation of Part Representations: Each part model is observed on the CAD system. Different views and orientations of the part are examined to ensure that a proper translation has been made. Different views of the part are examined to see if any geometry or annotation is incorrectly transformed.

36. Check Correct Translation of Scale and Units of Measurement: Reference features with a known size from the original part models are examined to verify that a correct translation of geometry size is made. Model scale and unit of measurement (metric vs. English) should be maintained after translation.

37. Obtain Hardcopy of IGES Translation: A plot is made of the translated part model using the same scaling factor that was used to document the original untranslated part model. The plot should be made on lightweight transparent material so that is can be used as an overlay for Step 43. Three-dimensional models are plotted in three views using orthographic projections and in a fourth view using an isometric perspective.

38. Functionality Check: This portion of the test is designed to see whether the model is a functional part of the CAD database or just a graphical image. Functionality is defined as the ability to manipulate and edit the part model as if it has been originally created on the CAD system being tested. Checks of geometric functionality can be made by rotating the entity, by copying selected entities, or by performing such analytical operations as line intersections and distance calculations. Thus, the functionality of geometric entities is checked through a number of indirect means during several points of post-processor evaluation.

    To ensure the functionality of annotation, each piece of annotation is selected and moved on the CAD system. In addition, the text is modified to examine the ability to make use of the CAD editor and to determine how many lines of text are grouped under one dimension.

    When evaluating the functionality of a post-processed IGES file, it is important to note that user requirements will determine the extent of annotation functionality required. Non-functonal graphic translations may look exactly like the original blueprint from the sending system, but the dimensions can only be modified by recreating new dimensions. Because of the differences in CAD system annotation packages, functional translations will contain annotation that may look somewhat different than the original drawing to allow it to be an integrated portion of the CAD database. Because each CAD system has various capabilities, a CAD operator with extensive experience and knowledge of the system is required to perform this step.

39. Evaluate Annotation: Each piece of annotation is analyzed to determine what individual entities are contained in a dimension. The CAD operator breaks down the annotation elements into the lowest level possible for the particular CAD system being tested. Some of the questions the CAD operator answers are as follows:

- What elements make up the dimension?
- Are leaders and witness lines an integral part of the dimension?
- Is the text part of the dimension?
- Is the dimension comprised of any geometry?

As in Step 28, a CAD operator with extensive experience and knowledge of the system is required to perform this step. Results from this step can be compared to the original documentation for the part model generated in Step 4. This indicates how the annotation has been mapped between the CAD systems.

40. Check Geometric Entity Mappings: In this step, the CAD model is analyzed to determine how geometric entities are mapped between the sending and receiving systems. The CAD operator selects the same geometric entities that were labeled in Step 4. This step verifies how the entities are translated on the receiving system. By completing this step, an understanding of how geometry is mapped between the two CAD systems can be determined.

41. Check Wireframe Geometric Accuracy: This portion of the evaluation is performed using part models that were originally created in the manner explained in Step 2. This type of file contains a wireframe part model that has points distributed over each goemetric entity. The CAD operator finds the distance from the points to the geometric entity that the points were originally placed on. If non-zero, this distance represents the error that occurs during post-processing of geometric entities. (This assumes that the IGES files contained correctly defined geometry before post-processing).

42. <u>Check 3D Surfaces:</u> Surfaces are tested in the same fashion as in wireframe geometry. Part models that are originally created with the method established in Step 2 are evaluated by finding the distance from the point to the surface. Theoretically, this should be zero for all points. This distance represents the error that occurs during post-processing of surfaces. If specific lines were created to intersect the surface, then the error is found by determining the intersection point of the line and the surface. The difference between this intersection point and the intersection point documented in Step 2 is the error associated with the surface translation.

43. <u>Compare Hardcopy of IGES Translations with Original Part Plots:</u> The hardcopy obtained from the plotting of the IGES translation in Step 37 is compared with the original part plot. This comparison consists of overlaying the hardcopy with the original part model plot. Differences found between the IGES translation and the original part model plot are documented as discrepancies. Discrepancies that are found during the checking of 3D surfaces, or during the checking of point parameters are also recorded. Possible differences could include items such as:

- Incorrect text aspect ratios
- Missing features
- Improperly located or incorrect annotation
- Distorted entity representations.

* * * * *

Upon completion of the test, the test data are evaluated using the criteria described in Section 3.0. The reader is encouraged to refer to Volume II of this report for an example of how these criteria were used to evaluate a series of IGES processors. However, it should be recognized that the evaluation performed during Task I, as reported in Volume II, was done to determine the level of implementation of IGES throughout the U.S. community of CAD vendors and users. Specific applications of this test methodology may require more or less emphasis of certain criteria to suit the particular situation.

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